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PLEURAL PLAQUES AND ASBESTOS: FURTHER OBSERVATIONS ON ENDEMIC AND OTHER NONOCCUPATIONAL ASBESTOSIS

Raimo Kiviluoto

Tampere Central Hospital, Tampere, Finland

Association between exposure to asbestos and neoplasia, increasing world production of asbestos and the possibility of environmental and other nonoccupational exposure to asbestos, have caused an increased interest of medicine in this mineral. In this connection, asbestos may gain considerable fame as a new discovery. However, it had that thousands of years ago. About 4500 years ago, asbestos was generally used in Finland as a cementing agent in the preparation of clay pottery. Asbestos ceramics, according to archeologic finds a Finnish invention, was used during a period of 3000 years. Approximately 500 A.D. the use of asbestos ceramics in Finland and its neighboring countries slowly ceased to be reused first about 1,000 years later.[1] Thousands of years ago, asbestos was in everyday use by families and consequently the Stone Age men "geologically" well knew where asbestos could be obtained.

Anthophyllite-asbestos is a fairly common mineral in Finland and tremolite-asbestos is especially characteristic of the Karelian formations in Northern Karelia. Anthophyllite has been mined since 1918, the annual output being around 15,000 metric tons.

Near two open asbestos mines several hundred cases of pleural calcification were found in people not employed in the mining industry.[2] Corresponding observations have been reported in East Germany.[3,4] Pleural plaques, as described in these reports, were similar to those characteristically seen in asbestos workers. Regardless of the type or degree of pulmonary reaction or fibrosis, these cases may be called cases of endemic asbestosis, until a better specification is found (pleural asbestosis?).

Pulmonary Fibrosis in Endemic Asbestosis

The majority of endemic cases of pleural calcification showed no subjective symptoms of a respiratory distress. Slight pulmonary fibrosis was roentgenologically detectable in about 14 per cent of 150 cases. The evaluation *in vivo* of the degree of fibrotic changes and their possible connection to asbestos dust is very complex and difficult. As a result of pathologic lung changes, the heart also may be affected. To study this, the following comparison was drawn: A roentgenologic volume measurement of the heart was made in 130 pleural plaque cases by using three right-angled heart diameters, two horizontal and one sagittal. Control material was gathered by taking the [illegible]es nearest to the plaque cases in the roentgen file. Thus, the age distribution in both groups automatically was similar, since the files are kept according to the birth number (year, month, day) and the control material was purely incidental. Heart volumina of the plaque group were 18 per cent greater than those of the controls.

In a group of 38 plaque cases and 23 control cases, pulmonary function tests were performed. Here only the vital and diffusing capacities are taken into consideration. The diffusing capacity measured by CO-method using rebreathing technique, was pathologically decreased in nine cases of the material and two cases of the control. Statistically the difference is insignificant. The mean vital capacity was 3600 in the material and 4000 in the control series. The reduction in vital capacity was statistically significant at 95 per cent level (analysis of variancy, F = 4.76).

Because reduction in vital capacity may occur in many diseases and regarding to the statistical insignificancy of the difference in diffusing capacity, positive conclusions are impossible. In endemic asbestosis, the possibility of pulmonary fibrosis must nevertheless still be taken into account.

Pulmonary and Pleural Neoplasia and Asbestos in Northern Karelia

Pulmonary and pleural neoplasia occur in a high percentage among asbestos workers, as is already well known. A close relationship has even been stated between environmental exposure to asbestos and pleural mesotheliomas.

Two hundred and sixteen cases of histologically proven lung carcinoma, found during 1958-61 in the Central Hospital of Northern Karelia, were used as a material for studying the asbestos-neoplasia problem. The areal distribution of all 216 cases did not show a higher incidence round the two asbestos mines, but corresponded to the areal distribution of pulmonary tuberculosis and cardiac insufficiency. Coincidence of endemic asbestosis and pulmonary carcinoma was observed in 21 cases. A comparison between the latter mentioned and carcinomata without asbestosis, as to the site of the tumor (upper or lower lobe), was drawn. In 67 advanced cases locating the tumor was not possible because of diagnostical difficulties. The tumor site in coincidental cases was on right 7 upper/6 lower lobe and on left 2 upper/3 lower lobe, and in other cases 48 upper/21 lower lobe on right and 43 upper/19 lower lobe on left. Four cases occurred with a tumor penetrating the thoracic wall. These showed signs of endemic asbestosis.

During 1959-62, the Central Hospital paid special attention to the possible occurrence of pleural mesothelioma. However, only one case was recorded. Preliminary clinical diagnosis was cholecystitis and chest roentgenogram showed pleurisy on right. After antibiotic therapy without success and increase of right chest pain, ple) tumor was suspected.

Thoracotomy revealed tumor infiltration in the basal pleura and histology proved a pleural mesothelioma. Lifelong environmental asbestos exposure occurred in this case.

Compared to the high incidence of benign pleural lesions or plaques among population environmentally exposed to asbestos, pulmonary and pleural neoplasia are rare. Especially the vague areal distribution of pulmonary carcinoma in Northern Karelia counteracts a positive conclusion concerning causal relationship between endemic and pulmonary carcinoma. It should also be noted, that in the series of 216 cases the distribution by sex was 216 male, 0 female. No explanation for this was detectable.

Cases of Pleural Plaques Found in Central Finland

Among 35,000 routine chest roentgen examinations during 18 months in 1963-64, 77 cases of pleural plaques were found. Roentgenologically these were similar to those seen in endemic asbestosis. Of the 77 cases, 68 were questioned concerning a possible occupational or other exposure to asbestos and mixed dusts. The results are presented in TABLE 1, also showing the occurrence of roentgenologically detectable pulmonary fibrosis in these cases. In cases without any detectable exposure to dusts, pulmonary changes were slight or absent, and the patients showed no subjective symptoms of respiratory distress, whereas e.g. the bricklayers had various degrees of dyspnea and showed roentgenologically definite pulmonary fibrosis associated with local emphysematous areas. In most cases with pulmonary fibrosis, visceral pleural adhesions, directed from the plaque to the lung, were discernible especially using fluoroscopically aimed various oblique projections. This phenomenon was not found in plaque cases without pulmonary fibrosis.

The discovery of an asbestos dust exposure in case history is often very difficult. A 50-year old woman had been treated over a period of several years for an unspecific dyspnea. The clinical diagnoses were asthma or cardiac insufficiency. The patient showed typical bilateral pleural calcification. However, she denied any possibility of asbestos exposure or even having ever visited the mining area. Two years later the patient came upon the following information. As a five-year old child she had spent three months in the immediate vicinity of the asbestos mill. As many others, she had used bunches of asbestos fibers as a playing material.

With the basis of previous observations on endemic asbestosis in Eastern Finland and further examinations concerning the severity and duration of exposure, it can be noted, that the plaques develop very slowly. It seems apparent that even very slight exposure over a short period may cause pleural changes many years or even decades later. The problem presented by the time factor, very different to that seen in occupational constant expo-

TABLE 1
PARTICULARS CONCERNING 77 CASES OF PLEURAL PLAQUES FOUND IN 35,000 ROUTINE CHEST ROENTGEN EXAMINATIONS AT TAMPERE CENTRAL HOSPITAL DURING 18 MONTHS IN 1963-64

Occupation	Number of cases	Roentgenological evidence of pulmonary fibrosis	Normal or very slight fibrosis	Exposure
Bricklayers	8	6	2	Intermittent exposure to mixed dusts containing asbestos.
Building workmen	7	2	5	
Factory workers, etc.	20	6	14	Very slight exposure to dusts without known asbestos
At random	25	4	21	Not detectable
—	2	0	2	Born in Kuusjärvi, Eastern Finland. Environmental exposure to asbestos.
—	1	0	1	Husband exposed to asbestos 20-28 years previously.
—	4	1	3	Father exposed to dusts containing asbestos.
	77			

sure, highly complicates the chances to prove whether or not there has been a dust exposure and/or any relationship to asbestos.

The four (last) cases in TABLE 1 deserve special attention. The first was found in routine chest-photofluorograph. The case history revealed that the patient's father had 50 years ago been occupationally exposed to mixed dusts. This was the only possible connection to asbestos. For further information the husband of the patient and her three sisters were examined. The husband showed no pathological changes in the lungs or pleurae, but all three sisters had bilateral pleural changes, two had very typical pleural plaques. One of them also had visceral pleural adhesions and pulmonary fibrosis. All but the last mentioned were subjectively symptomless. Histology of biopsy material taken by thoracotomy, revealed pulmonary and

pleural fibrosis and in four micron thick paraffin sections no asbestos fibers were visible.

Comments

In advanced cases of pleural plaques, roentgen diagnosis is easy. Misinterpretations as lung or pleural tumors are possible, especially if relationship to asbestos or dusts is not known. In the literature, benign local parietal pleural changes "of obscure origin" consisting of hyaline sclerotic fibrin, at first misinterpreted as lung or pleural tumors, have also been reported.[7] To judge from the description of those pleural changes, they seem very similar to those seen in asbestosis.

The correct roentgenological observation and interpretation of parietal pleural plaques enables discovery of pneumoconiosis even in cases which show no other clinical evidence of an inhalation damage. Even though not pathognomonic to asbestosis, pleural plaques are of significance for industrial hygiene and may be very helpful in epidemiologic studies.

The detection of exposure to asbestos or mixed dusts is often very difficult in case histories, mainly because the interval between exposure and manifestation may range from several years to decades. Also, it should be noted that asbestos is found with great difficulty in paraffin sections of ordinary thickness.[8] In cases of pleural plaques asbestos may be found more often if they are specially searched for and if special methods are used.

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OBSERVATIONS ON ATMOSPHERIC AIR POLLUTION CAUSED BY ASBESTOS

Arvo Laamanen, Leo Noro, V. Raunio

Institute of Occupational Health, Helsinki, Finland

Introduction

The mining (quarrying) of asbestos in Finland has been carried out for approximately fifty years. Current production is about 15,000 tons of anthophyllite asbestos per year. In his work on nonoccupational endemic asbestosis, published in 1960, R. Kiviluoto found calcifications of pleura on X-ray examination in approximately 500 people living around the mines.[1] V. Raunio, who at present is continuing the study of the incidence of pleural calcifications in the population around the mines, has mentioned that 1,300 more cases have been found. Kiviluoto, however, estimates that about ten per cent of the population living around the mines might have pleural plaques. At the request of V. Raunio and the Finnish Asbestos Company, Suomen Mineraali, the Institute of Occupational Health has performed some air pollution studies around the mines, to investigate the presence of asbestos in the air. Some preliminary observations have been made which are included in the following material.

First Survey

This was undertaken from August 20 to November 28, 1961, and samples were taken at 13 places around the mines. British Deposit Gauge apparatus, commonly used in many countries, was employed. Simultaneous meteorological observations were made at a neighboring station (Outokumpu) about 30 km. from the mine. Besides standard asbestos dust, dust that had passed through the ventilation system of the asbestos mill, and dust which was found on plant leaves in the neighborhood, was used in the analysis. The asbestos was measured with a Philips Roentgen Difractometer in the State Geological Institute. The material had been subjected to ashing at 550°C. Ash analysis with the difractometer yielded the following results:

Radiation, Cu/Ni 32 kV, 12 mA.
Slits, 1-001-1.
Set, 8-4-1.
Speed, ½/min.

The results of the first survey are seen in TABLE 1.

These results indicate that the amount of asbestos deposited at the different observation points depended on the distance from the mines and the mill. However, the amount of dust also depended on geographical and

TABLE 1
RESULTS FROM FIRST SURVEY (AUGUST 20-NOVEMBER 28, 1961)

Observation site, distance from mines in km.	Direction of mines from observation site	Deposited asbestos in g./100 m.^{2}/month
0.5	SW	34.6
0.5	N	12.7
1	S	9.6
1	NE	12.4
1	NW	6.2
2	W	1.5
2	S	0.9
2	E	1.7
4	N	0.7
4	S	0.8
4	E	1.1
11.5	N	0.3
13.5	S	—

meteorological conditions. Observations points 2 S and 1 NW were located behind a hill near the mine, and behind a typical Finnish forest, which was the reason the amounts of dust collected were minor, when compared to other points at the same distance from the mine. The meteorological data indicated prevailing winds from the south or southwest. This certainly had its effect on the quantity of asbestos collected at point 0.5 S.W. which was almost three times as much as that of a corresponding distance in almost opposite direction. Low wind velocity had almost the same effect. When the wind speed increased, the radius of the dissemination of the suspended material increased in the direction of the wind. This may explain the results of 11.5 N and 13.5 S.

Second Survey

This survey was made between June 25 and November 29, 1963. While in the first survey the greatest distance between the mines and an observation point had been 13.5 km, in the second it was set at 50 km (point 1 in FIGURE 1), because V. Raunio had found that the incidence of pleural plaques stayed significant, even when farther away from the mines.

Five communities (FIGURE 1), i.e. Tuusniemi, Kaavi, Polvijarvi, Kuusjarvi, and Heinavesi, were included in this investigation. Of the previous observation sites 4 S (4) was kept at the same place. Two sites (25 N_1 and [illegible]$_2$; 2 and 3 in FIGURE 1) were located close to each other to

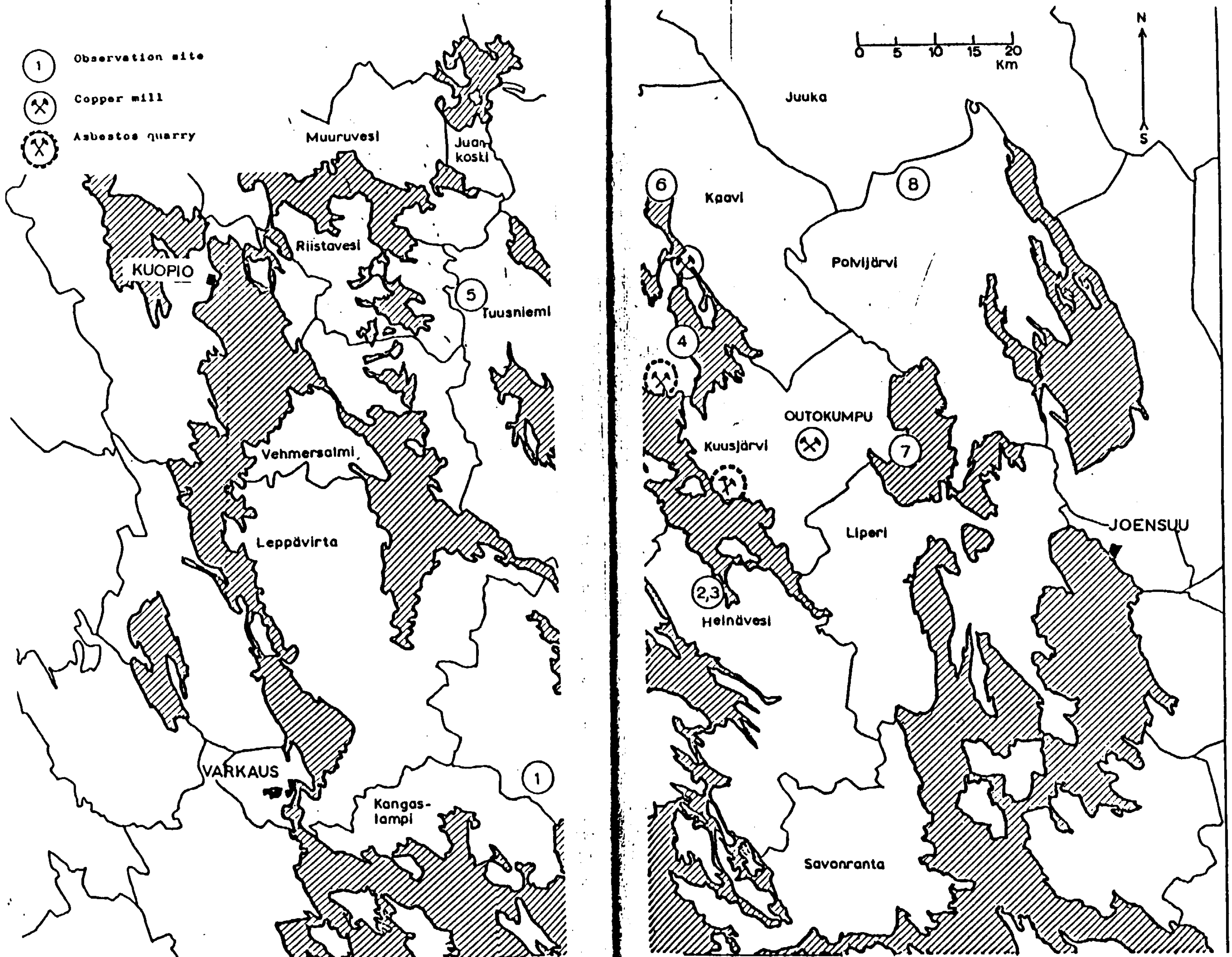

FIGURE 1. Map of the area surrounding the asbestos mines.

TABLE 2
RESULTS FROM SECOND SURVEY (JUNE 25-NOVEMBER 29, 1963)

Observation sites, distance from mines in km.	No. on fig. 1 (map)	Direction of mines from observation sites	Deposit of asbestos in g./100 m.^{2}/month
4	4	S	1.52
18	5	SE	0.88
25	2	N_1	—
25	3	N_2	traces
27	6	S	1.38
30	7	W	—
42	8	SW	—
50	1	N	traces

eliminate the possible influence of purely local factors. The results of this survey are tabulated in TABLE 2.

Meteorological Observations

Meteorological observations are extremely important in connection with air pollution studies, since dissemination and movement of fine particles depend in considerable degree on rain, and the direction and velocity of the wind. However, meteorological conditions in this part of Finland are rather stable. Meteorological observations at one observation point are summarized in FIGURE 2, in which the length of the air direction vector gives the percentage of the number of times the wind blew in this direction when the observations were made three times daily: at 8 a.m., 2 p.m., and 8 p.m. The wind velocity is indicated by the width of the direction vector.

The sampling period in the second survey was longer, so local weather changes could be eliminated. The greater asbestos quantity in control sample 4 S compared with that of the previous survey (0.8 g. per 100 m.^{2}/month) can be explained by the fact that the wind directions were more favorable, as was the rainfall. During the survey the wind was often from the south or southwest, with relatively high velocities. This also explains the asbestos at 18 SE and 27 S. The results from the twin sites 25 N_1 and 25 N_2 look rather peculiar, but in the one sampling bottle were found hundreds of insects. This also was the case in sample 50 N, although here there were fewer insects. It can only be surmised that the traces of asbestos came with the insects. At the time, they were not identified, since they were not considered to be of great value; the matter could, no doubt, have been checked microscopically.

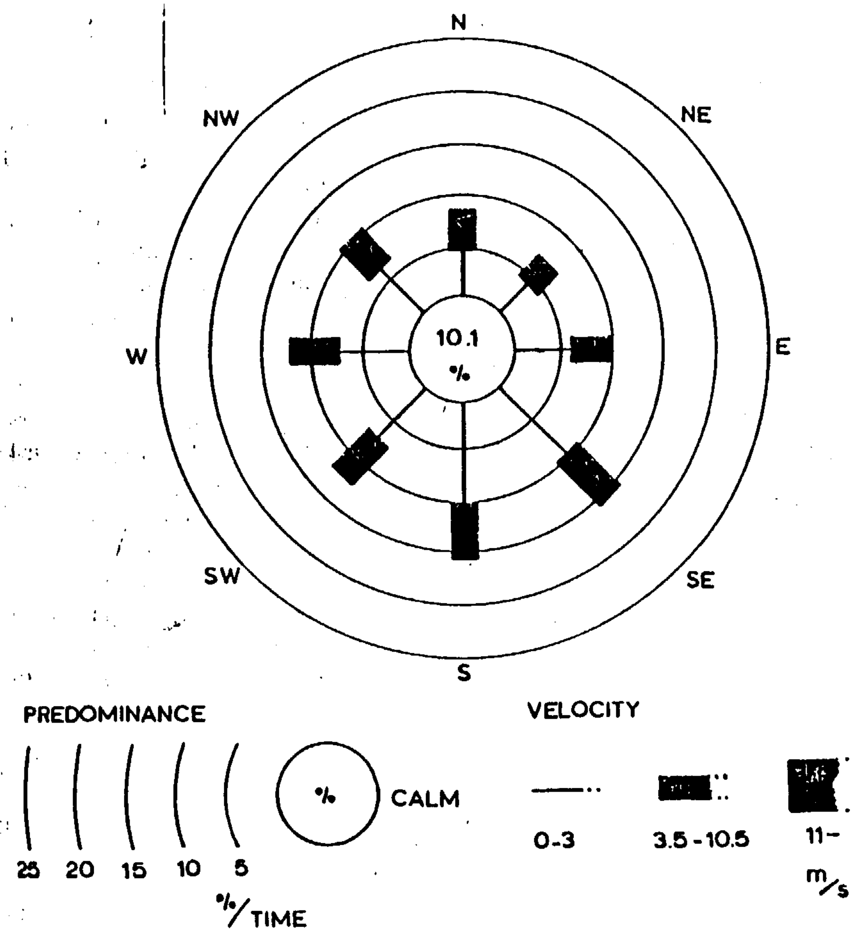

FIGURE 2. Wind observations at Outokumpu during the Second Survey.

Summary

These two preliminary air pollution surveys indicate that asbestos dust is disseminated from mining (quarrying) and milling areas rather extensively, while the degree of pollution varies with the distance from the source and the prevailing winds. Investigations are continuing (V. Raunio) on the correlation between the incidence of pleural plaques and the degree of air pollution caused by atmospheric asbestos.

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